PATENT ABSTRACTS OF JAPAN

(11)Publication number : 09-231834
(43)Date of publication of application : 05.09.1997

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(51)Int.Cl.
H01B 1/22
C09J 9/02
H05K 1/09
// H05K 3/12

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(21)Application number : 08-062056
(22)Date of filing : 23.02.1996

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(54) COPPER CONDUCTIVE PASTE FOR FINE LINE PRINTING AND SUBSTRATE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide copper conductive paste for fine line printing which makes the printing of a fine line on a substrate easy, enhances the adhesion of the conductor with the substrate, and in addition, decreases the electric resistance value of the conductor, and provide the substrate.

SOLUTION: A conductor paste for fine line printing is prepared by adding the mixed copper powder obtained by adding at least one kind of auxiliary copper powder having a mean particle size of 0.1-0.5μm to base copper powder having a mean particle size of 0.3-1μm and an organic solvent to a polymer composite material obtained by dispersing without aggregation micro-particles of copper, copper oxide, or a mixture of them in a polymer.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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CLAIMS

[Claim(s)]
[Claim 1] To the macromolecule composite which was distributed without condensing the ultrafine-particle-ized copper, copper acid ghosts, or such mixture in a macromolecule, and was obtained The mixed copper powder which added at least one or more kinds of auxiliary copper powder of the range which is 0.1-0.5 micrometers with mean particle diameter smaller than this to base copper powder with the largest mean particle diameter in the range whose mixed copper powder is the mean particle diameter of 0.3-1 micrometer, And copper conductive paste for fine line printing characterized by coming to add an organic solvent.
[Claim 2] Copper conductive paste for fine line printing according to claim 1 which added binder resin.
[Claim 3] After a macromolecule composite produces the macromolecule layer which un-equilibrated thermodynamically and sticks a copper metal layer to the front face of this macromolecule layer, Copper conductive paste for fine line printing according to claim 1 obtained by making it distribute, without making the ultrafine particle of the copper ultrafine-particle-ized from this metal layer by heating the above-mentioned macromolecule layer and stabilizing a macromolecule layer, copper acid ghosts, or such mixture condense in a macromolecule.
[Claim 4] Copper conductive paste for fine line printing according to claim 1 or 2 with which 0.1-2.0 weight section addition of the glass powder is carried out to a total of 100 weight sections of the ultrafine-particle-ized copper, copper acid ghosts or such mixture, and mixed copper powder.
[Claim 5] Copper conductive paste for fine line printing according to claim 1 or 2 organic [the amount of / which consists of an organic solvent and a macromolecule] is in 2 - 16% of the weight of the range.
[Claim 6] To the macromolecule composite which was distributed without condensing the ultrafine-particle-ized copper, copper acid ghosts, or such mixture in a macromolecule, and was obtained The mixed copper powder which added at least one or more kinds of auxiliary copper powder of the range which is 0.1-0.5 micrometers with mean particle diameter smaller than this to base copper powder with the largest mean particle diameter in the range whose mixed copper powder is the mean particle diameter of 0.3-1 micrometer, And the substrate characterized by printing and calcinating on a substrate the copper conductive paste which comes to add an organic solvent.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the copper conductive paste for fine line printing, and a substrate, and relates to the copper conductive paste for fine line printing and the substrate of a fine line which can be printed on a substrate in detail.
[0002]
[Description of the Prior Art] Conductive paste is used, in order to print a circuit and to make up for a conductor today to the through hole which is the through hole prepared on the ceramic substrate at the substrate. As this conductive paste, there are a silver system paste, a golden system paste, an Ag-Pt system paste that uses silver and platinum as a principal component, and copper system pastes including the Ag-Pd system paste which uses silver and palladium as a principal component.
[0003] Among these, although an Ag-Pd system paste is typical as a wiring application, it also has some fault points. for example, the case where a paste is used for wiring on a substrate -- the moisture in air etc. -- minding -- silver -- ionizing -- this ionized silver -- the next conductor -- the phenomenon called the migration which it shifts [migration] to a way and makes a circuit short-circuit had occurred. for this reason, a conductor -- distance between ways was not able to be narrowed. moreover, a conductor -- other components were carried in the road, or it was easy to corrode silver to a pewter in the soldering part for connecting, and pewter-proof nature was inferior.
[0004] Moreover, when pasting up the above-mentioned paste on a substrate, since reaction adhesion of the metal particle of micron size was not able to be carried out with a ceramic substrate, originally, about 4 - 10% of the weight of the glass frit was blended in the paste, and the role which pastes up a substrate and a metal membrane after the glass frit in the substrate after printing calcinating had been given. On the other hand, since the electric resistance value of a metal membrane became high since it remained so much also in the metal membrane after a glass frit calcinating, and the metal membrane and the substrate were pasted up in the glass layer, the problem said that it becomes easy to come out of distortion by the differential thermal expansion, and thermal shock nature becomes weak occurred.
[0005] It considers as the paste which canceled a part of such a fault point, and the copper system paste is known. It consists of a presentation which distributed the glass powder object, such as a metal copper grain child [which covered the copper acid ghost as it consisted of a presentation which distributed the non-/, such as copper and glass FIRITTO and a tungsten, molybdenum and a rhenium, / copper system matter in the organic solvent as this paste was indicated by JP,60-70746,A and indicated by JP,3-50365,B], and copper acid ghost particle, and glass, in the organic solvent.
[0006]
[Problem(s) to be Solved by the Invention] The above-mentioned copper system paste also added many of 4 - 10% of the weight of the glass frit preferably as a glass powder object, and has played the role [conductor / a substrate and] of adhesion. However, when calcinating and pasting up a substrate and a conductor after applying the above-mentioned paste to a substrate, too, it remained so much, and the electric resistance value of a conductor was high, and it was easy to come in the metal membrane after a glass frit calcinating out of a distortion according [the glass layer in the interface of a conductor and a substrate] to thermal expansion, and the problem to which thermal resistance and thermal shock nature become weak remained as before. This thermal shock resistance is evaluated from the adhesive strength of the conductor and a substrate after repeating and moving a substrate with a conductor to that hard flow from a low-temperature ambient atmosphere to an elevated-temperature ambient atmosphere again.
[0007] Moreover, since the lead borosilicate glass which has the softening temperature when a glass frit is also low was used, at the plating process of antioxidizing or Au wirebonding performed for accumulating, the lead in the above-mentioned glass had checked plating. Furthermore, since the particle size of the metal added in the above-mentioned

copper system paste was large, the about 50-100-micrometer fine fine line was printed on the substrate, and it was difficult for it to produce the calcinated conductor.

[0008] This invention improves such a trouble, makes printing of a fine line easy on a substrate, and aims at offering the copper conductive paste for fine line printing and the substrate to which it not only improves the adhesive strength of a conductor and a substrate, but it reduced the electric resistance value of a conductor.

[0009]

[Means for Solving the Problem] To namely, the macromolecule composite which was made to distribute this invention, without condensing the ultrafine-particle-ized copper, copper acid ghosts, or such mixture in a macromolecule, and was obtained The mixed copper powder which added at least one or more kinds of auxiliary copper powder of the range of 0.1-0.5 micrometers where mean particle diameter is smaller than this to base copper powder with the largest mean particle diameter in the range whose mixed copper powder is the mean particle diameter of 0.3-1 micrometer, And it is in the copper conductive paste for fine line printing which comes to add an organic solvent.

[0010] Moreover, this invention includes the case where binder resin is added, the case where 0.1-2.0 weight section addition of the glass powder is carried out to a total of 100 weight sections of the ultrafine-particle-ized copper, copper acid ghosts or such mixture, and mixed copper powder, and the case where organic [the amount of / which consists of an organic solvent and a macromolecule] is in 2 - 16% of the weight of the range.

[0011] To furthermore, the macromolecule composite which was made to distribute this invention, without condensing the ultrafine-particle-ized copper, copper acid ghosts, or such mixture in a macromolecule, and was obtained The mixed copper powder which added at least one or more kinds of auxiliary copper powder of the range of 0.1-0.5 micrometers where mean particle diameter is smaller than this to base copper powder with the largest mean particle diameter in the range whose mixed copper powder is the mean particle diameter of 0.3-1 micrometer, And the substrate which printed on the substrate the copper conductive paste which comes to add an organic solvent, and calcinated it is included.

[0012]

[Function] The gap and opening which auxiliary copper powder produces according to the array of base copper powder are filled up with the copper conductive paste for fine line printing and the substrate of this invention, there is no internal defect, baked tightness can also obtain a good conductor, and it can apply also to printing of a fine line by making base copper powder smaller further. moreover, the adhesive strength of a conductor and a substrate is improved in the copper conductive paste which added the glass powder object -- it can make -- moreover -- the addition of a glass powder object -- the former -- comparing -- a pole -- since it excels in pewter nature since it is little, and the layer of a glass powder object with it is not formed, thermal shock nature also improves. [the low and electric resistance value of a conductor and] [clear to the interface of a conductor and a substrate] And the stopgap nature after baking of the paste with which it was easy to fill up a through hole with, and the through hole was filled up is also good, and even after printing, it turns out that configuration maintenance can be performed.

[0013]

[Embodiment of the Invention] The macromolecule composite used as the 1st component of the copper conductive paste in this invention, After producing the macromolecule layer which un-equilibrated thermodynamically and sticking a copper metal to the front face of this macromolecule layer at least, It is made to distribute, without particle size making the copper acid ghosts and copper which consist of 1-50nm ultrafine-particle-ized Cu_2O or CuO preferably 100nm or less, or such mixture condense in a macromolecule from a copper metal by heating the above-mentioned macromolecule layer and stabilizing a macromolecule layer. The content of the ultrafine particle of a copper acid ghost is 10 - 90 % of the weight preferably 90 or less % of the weight. while the copper acid ghost of an ultrafine particle, copper, or such mixture have high reactivity at low temperature and promoting a copper powder comrade's sintering -- a substrate and reaction adhesion -- carrying out -- the big conductor of adhesive strength -- the film is formed.

[0014] When obtaining the above-mentioned macromolecule composite, it is necessary to fabricate in the condition of having un-equilibrated the macromolecule layer thermodynamically. The vacuum deposition approach which this is heated, and a macromolecule is dissolved, and it evaporates it in a vacuum, and specifically solidifies a macromolecule layer on a substrate or a thermal decomposition method, and a macromolecule are dissolved above a melting out temperature, and it supplies to liquid nitrogen etc. immediately with this condition, and quenches, and there is the fusion quenching solidification approach of making a macromolecule layer adhering on a substrate etc.

[0015] Among those, using the usual vacuum evaporation system, by 10 degree of vacuum [of -4 - 10-6Torr] and evaporation rate [of 0.1-100 micrometers]/, it is a part for 0.5-5-micrometer/preferably, and, in the case of the vacuum deposition approach, a macromolecule layer can be obtained on substrates, such as glass.

[0016] A thermal decomposition method is an approach of manufacturing the condition (it having metastable structure) playback macromolecule which un-equilibrated thermodynamically by pyrolyzing and evaporating the macromolecule which is a raw material in the closed space under reduced pressure, and solidifying this evaporation object. After pyrolyzing and evaporating the thrown-in macromolecule of the specified quantity, this evaporation object is condensed to a playback macromolecule in a heat-treatment field, and it is the approach of obtaining the playback macromolecule with which an oil-like low-molecular-weight object is not intermingled, by condensing the evaporation object which was not condensed in an oil-like low-molecular-weight object in a cooling field.

[0017] Moreover, by the fusion quenching solidification approach, a macromolecule is dissolved, it cools the rate more than the critical cooling rate of this macromolecule proper, and a macromolecule layer is obtained. Thus, the obtained macromolecule layer is thermodynamically set in the unstable condition of having un-equilibrated, and shifts to equilibrium along with the passage of time.

[0018] The macromolecules used by this invention are nylon 6, Nylon 66, Nylon 11, Nylon 12, nylon 69, polyethylene terephthalate (PET), polyvinyl alcohol, a polyphenylene sulfide (PPS), polystyrene (PS), a polycarbonate, polymethylmethacrylate, etc., and what it has 2000 or more cal/mol as molecule cohesive energy is desirable. This macromolecule also contains the crystalline polymer and amorphous polymer which are usually said. In addition, about molecule cohesive energy, he is the edited by Chemical Society of Japan. It is defined as the 890th page edited (1974 issue) by chemistry handbook application by the detail.

[0019] Then, the macromolecule layer which un-equilibrated on said thermodynamics target is moved to the process which sticks a copper metal layer on the front face. At this process, a macromolecule layer is made to vapor-deposit a copper metal layer with a vacuum evaporation system, or the laminating of the copper metal layer is carried out to a macromolecule layer by the approach of sticking that metallic foil and a metal plate in a direct macromolecule layer.

[0020] The composite which the metal layer and macromolecule layer of the above-mentioned copper stuck is heated at the temperature below flow temperature more than the glass transition point of a macromolecule, and a macromolecule layer is made to shift to a stable state. Consequently, a copper metal layer is 100nm or less, it becomes the ultrafine particle of the copper acid ghosts and copper which have the max of particle size distribution in a 1-50nm field, or such mixture, and diffusion osmosis is carried out into a macromolecule layer, it continues until a macromolecule layer is completely stabilized by this condition, that thickness also decreases and, finally the metal layer of the copper adhering to a macromolecule layer is lost. The above-mentioned ultrafine particle is distributed in a macromolecule layer, without condensing. In addition, when a macromolecule layer is heated at this process, it turns out that the macromolecule layer showed coloring of a proper by the interaction with the ultrafine particle of a copper acid ghost, copper, or such mixture, and the above-mentioned ultrafine particle has permeated into a macromolecule layer. Moreover, this color may change with the particle diameter of an ultrafine particle which consists of a copper acid ghost, copper, or such mixture, and the classes of macromolecule.

[0021] In this invention, the manufacture approach of a macromolecule composite produces the ultrafine particle of a copper acid ghost, copper, or such mixture with the gaseous-phase method not only belonging to for example, the above-mentioned approach but the melting evaporating method, the liquid phase process belonging to settling, a solid phase technique, and a variational method, evaporates in coincidence the approach of mixing this ultrafine particle with the macromolecule which consists of a solution or melt on a machine target or a macromolecule, and an ultrafine particle, and has the approach of mixing in a gaseous phase etc.

[0022] Moreover, the mixed copper powder which is the 2nd component of the copper conductive paste of this invention consists of mixed copper powder which added at least one or more kinds of auxiliary copper powder of the range of 0.1-0.5 micrometers where mean particle diameter is smaller than this to base copper powder with the largest mean particle diameter in the range whose mixed copper powder is the mean particle diameter of 0.3-1 micrometer. The thing by which concrete mixed copper powder added 0.1 micrometers to the mean particle diameter of 0.5 micrometers and the thing which added 0.5 micrometers and 0.1 micrometers to 1 micrometer, or the thing which added 0.3 micrometers and 0.1 micrometers to 0.5 micrometers is used. In the case where the above-mentioned mixed copper powder is constituted from two steps of particle diameter range, the 2nd auxiliary copper powder is [base copper powder] 2 - 20% of the weight to 80 - 98 % of the weight among mixed copper powder. Especially about auxiliary copper powder, the 3rd auxiliary copper powder below the range of such mean particle diameter may be used, without being limited to this.

[0023] Each copper powder of the above-mentioned auxiliary copper powder has a desirable thing comparatively near a globular form. This is for each copper powder to lessen an opening and to arrange it. If the copper powder from which mean particle diameter differed is used, since the small auxiliary copper powder of mean particle diameter will be filled up with the clearance and opening which are produced when the biggest base copper powder of mean particle diameter arranges, the conductor after baking has few internal defects, and baked tightness has the effectiveness it is good ineffective.

[0024] If the mean particle diameter of base copper powder exceeds 1 micrometer, baking conditioning will become large that it is hard to be influenced of oxidation. However, printing of a fine line becomes impossible rather than anything. On the other hand, by less than 0.3 micrometers, the total granular structure product of mixed copper powder becomes [the mean particle diameter of base copper powder] large too much, the effect of oxidation becomes large, and an electric resistance value becomes high. Moreover, since the umbrella consistency is large, baked tightness nature worsens.

[0025] If the addition of base copper powder exceeds 98 % of the weight, at low temperature, it burns without fully sintering, the lack of tightness arises, a conductor, a substrate, and adhesive strength with a through hole decline, on the other hand, by less than 80 % of the weight, the total granular structure product of mixed copper powder will become large too much, and the same fault as the above-mentioned will happen. In addition, since it is filled up with the gap and opening which are produced when base copper powder arranges, auxiliary copper powder is added, and the mean particle diameter and addition receive effect in them of base copper powder greatly.

[0026] As the above-mentioned organic solvent, it is the organic solvent of high-boiling points, such as carbitol, carbitol acetate, the metacresol, dimethyl imidazolidinone, dimethylformamide, TAPI Norian, diacetone alcohol, triethylene glycol, paraxylene, ethyl lactate, an isophorone, and tetrahydrofurfuryl alcohol, and two or more kinds may be mixed.

[0027] The glass powder which is the 4th component added by this invention may be added in order to improve the crack of a conductor or to make the auxiliary role which improves biscuit ware support. This glass powder does not contain lead, but it has 200-700 degrees of softening temperatures C in the range with a mean particle diameter of 1-10 micrometers, and that addition has the desirable 0.1 - 2.0 weight section to the total quantity 100 weight section of all copper powder, the ultrafine-particle-ized copper acid ghost, copper, or such mixture. if the 2.0 weight sections are exceeded -- the conductor after glass powder calcinating -- since it remains inside, there is an inclination for the electric resistance value of a conductor to rise, and a glass layer is formed in the interface of a conductor and a substrate, it is easy to cause distortion by thermal expansion, and thermal shock nature becomes weak. On the other hand, neither the crack of a conductor nor the improvement of biscuit ware is expectable by less than 0.1.

[0028] Giant molecules other than the giant molecule of a giant-molecule composite can be added as binder resin to the copper conductive paste of this invention. As this resin, they are polyamides, such as acrylate, such as polyvinyls, such as polyethers, such as celluloses, such as a nitrocellulose, ethyl cellulose, cellulose acetate, and butyl cellulose, and polyoxymethylene, polybutadiene, and polyisoprene, poly butyl acrylate, and polymethyl acrylate, nylon 6, nylon 6 .6, and Nylon 11, for example.

[0029] And as for the copper conductive paste of this invention, organic [the amount of / which consists of an organic solvent and a giant molecule (binder resin is included)] is in 2 - 16% of the weight of the range. If the viscosity of conductive paste becomes high, and it becomes that a through hole is hard to fill up and organic [the amount of] exceeds 14 % of the weight, when organic [the amount of] is less than 2 % of the weight, since the paste with which the through hole was filled up will contract by baking, stopgap nature worsens.

[0030] Moreover, all the contained copper powder, the copper acid ghosts and copper which were atomized, or such mixture are in 84 - 98% of the weight of the range. If it exceeds 98 % of the weight, a paste serves as hyperviscosity, it burns, the lack of tightness arises, a conductor, a substrate, and adhesive strength with a through hole decline, and in order that the paste filled up with less than 84 % of the weight into the through hole on the other hand may contract by baking, the same fault as the above-mentioned will happen.

[0031] Thus, the obtained conductive paste is applied to ceramic substrates, such as an alumina, nitriding aluminum, silicon carbide, silicon nitride, sialon, barium titanate, and PBZT, by approaches, such as screen-stencil. In the bottom of the screen (for example, a stainless steel plain weave fabric, 300 meshes) placed horizontally, the procedure of screen-stencil gives spacing of several mm, and installs a printing substrate. After carrying conductive paste on this screen, it extends all over a screen using a squeegee. At this time, the screen and the printing substrate have spacing. Then, a screen prints by pressing down and moving a screen to extent in contact with a printing substrate by the squeegee. This is repeated henceforth.

[0032] This is put into the oven set as 60-200-degreeC, and it dries. At a preliminary baking process, after making it go up gradually from this laying temperature to 200-300-degreeC by part for programming-rate C[of 2-20 degrees]/, it holds for a maximum of 60 minutes at this temperature, and the decomposition behavior of an organic component is adjusted in the meantime. After this finishes, a preliminary baking substrate is put into a belt furnace, baking is carried out for 5 - 20 minutes (peak holding time) at the temperature of 600-1000-degreeC among nitrogen, and while making copper powder sinter, reaction adhesion is carried out with a substrate.

[0033]

[Example] Next, a concrete example explains this invention to a detail further.

Using one to examples 1-3 and example of comparison 2 (production of a macromolecule composite) vacuum evaporation system, polymer pellet 5g of Nylon 11 is put in into a tungsten board, and it decompresses to 10-6Torr. Subsequently, the electrical potential difference was impressed, the tungsten board was heated in the vacuum, the polymer was dissolved, and the macromolecule layer of the vacuum evaporationo film with a thickness of about 5 micrometers was obtained the rate for about 1-micrometer/on the substrate (glass plate) installed in the upper part of a mount with the degree of vacuum of 10-4 - 10-6Torr. The molecular weight of this macromolecule layer has become about 1 of said polymer pellet / two to 1/10.

[0034] Furthermore, the copper chip was put in into Haas, heating fusion was carried out with the electron beam, it vapor-deposited with the degree of vacuum of 10-4 - 10-6Torr, and the copper vacuum evaporationo film was made to adhere on a macromolecule layer. This was taken out from the vacuum evaporation system, in the thermostat held to 120-degreeC, it was left for 10 minutes and the composite was obtained. Consequently, in this macromolecule composite, Cu2 O contained 40% of the weight, and that particle size was 1-15nm.

[0035] (Production of copper conductive paste) A macromolecule composite, mixed copper powder, an organic solvent, and glass powder were mixed as shown in Table 1. Two sorts which consist of base copper powder and one kind of auxiliary copper powder as mixed copper powder were used. the above -- brown conductive paste was produced by mixing these and mixing to homogeneity in an ink roll further.

[0036] (Production of a conductor) The substrate for adhesive strength evaluation printed conductive paste to 2x2mm using the screen of polyester 200, and the substrate for electric resistance value evaluation printed conductive paste in diameter of 15mm using the screen of polyester 200. Furthermore, the substrate for through hole evaluation screen-stenciled conductive paste using the screen of polyester 200 on the alumina substrate which has two or more through holes with a diameter of 0.3mm, and stuffed conductive paste into coincidence in the through hole. It put into the oven which set these as 80-degreeC, and to 260-degreeC, by part for programming-rate C[of 5 degrees]/, the temperature up was carried out, it held for 10 minutes and preliminary baking was carried out. Then, the preliminary baking substrate was put into the belt furnace, it calcinated for peak holding-time 15 minutes in nitrogen with 0-10 ppm of oxygen densities, and the burning temperature of 900-degreeC, and the substrate was produced.

[0037] (The evaluation approach) The adhesive strength of the conductor after baking, the electric resistance value of a conductor and the adhesive property of the through hole stopgap section, stopgap nature, and a printing edge were measured by the following approaches.

[0038] 1. Conductor after Baking -- Membranous Adhesive Strength (L Type Peel Reinforcement)
the adhesion force of the copper wire which made it with the pewter the front face of the conductor calcinated in 2mmx2mm magnitude, fixed to it, and bent perpendicularly the tinning copper wire with a diameter of 0.8mm bent to the L type -- spring measure -- measuring -- a substrate and a conductor -- it asked for the adhesive strength of a between.

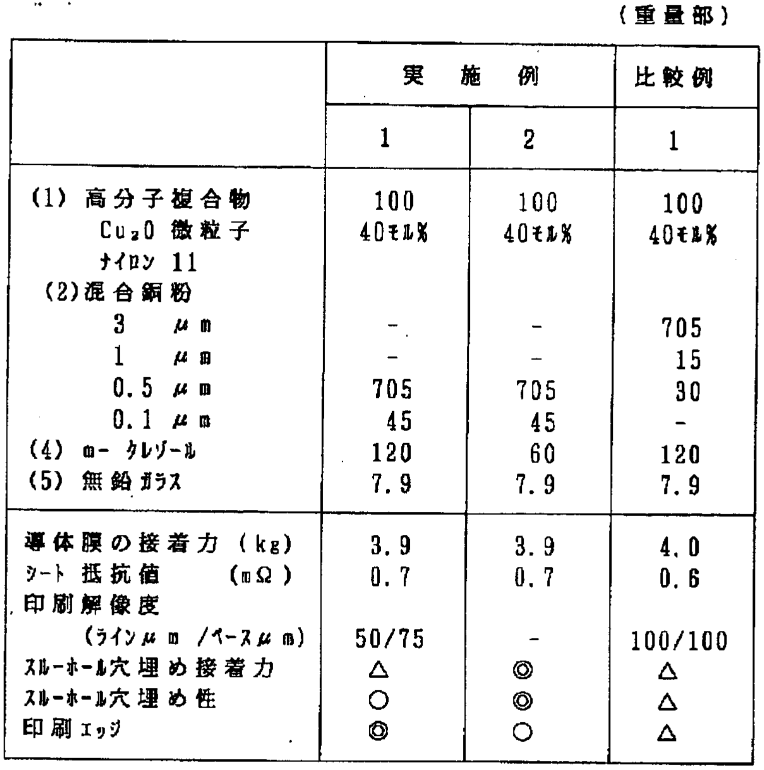
[0039] 2. The electric resistance value was measured with the four point probe method using the conductor with 10 micrometers [in thickness on the electric resistance value alumina substrate of a conductor], and a diameter of 15mm.

[0040] 3. The condition after wearing out the adhesive through hole stopgap section of the through hole stopgap section 1000 times with the Taber abrasion tester was observed with the naked eye. Evaluation is three steps, A and O are good and ** of O is poor.

[0041] 4. The stopgap section of a stopgap nature through hole was observed under the microscope. Evaluation is three steps, A and O are good and ** of O is poor.

[0042] 5. After giving spacing of several mm, installing a printing substrate in the bottom of the screen (a polyester plain weave fabric, 200 meshes) put on the printing edge horizontal and carrying conductive paste on this screen, extend all over a screen using a squeegee, and a screen prints continuously by making extent in contact with a printing substrate press down and move a screen by the squeegee. The substrate after printing was expanded under the microscope and the edge of a conductor was observed. That in which, as for that to which the center section is flat, the center section has become [become / O and an edge / as for that in which an edge is sharp and square / round] depressed by O and an edge becoming round was evaluated as **.

[0043]
[Table 1]



（重量部）

	実施例		比較例
	1	2	1
(1) 高分子複合物	100	100	100
Cu_2O 微粒子	40ﾓﾙ%	40ﾓﾙ%	40ﾓﾙ%
ﾅｲﾛﾝ 11			
(2)混合銅粉			
3 μm	-	-	705
1 μm	-	-	15
0.5 μm	705	705	30
0.1 μm	45	45	-
(4) m- ｸﾚｿﾞｰﾙ	120	60	120
(5) 無鉛ｶﾞﾗｽ	7.9	7.9	7.9
導体膜の接着力（kg）	3.9	3.9	4.0
ｼｰﾄ 抵抗値 （mΩ）	0.7	0.7	0.6
印刷解像度 （ﾗｲﾝμm /ﾍﾟｰｽμm）	50/75	-	100/100
ｽﾙｰﾎｰﾙ穴埋め接着力	△	◎	△
ｽﾙｰﾎｰﾙ穴埋め性	○	◎	△
印刷ｴｯｼﾞ	◎	○	△

[0044] According to this result, in the example, printing resolving is good and it turns out that it is easy to fill up a through hole and stopgap nature and a printing edge are also excellent.
[0045]
[Effect of the Invention] By as mentioned above, the thing for which the gap and opening which auxiliary copper powder produces according to the array of base copper powder are filled up with this invention, there is no internal defect, baked tightness can also obtain a good conductor, and base copper powder is further made smaller By being able to apply also to printing of a fine line and adding a glass powder object the adhesive strength of a conductor and a substrate is improved -- it can make -- moreover -- the addition of a glass powder object -- the former -- comparing -- a pole -- since it excels in pewter nature since it is little, and the layer of a glass powder object with it is not formed [the low and electric resistance value of a conductor and] [clear to the interface of a conductor and a substrate] It has the effectiveness that thermal shock nature also improves.

[Translation done.]